

Integrating Workplace Exposure Databases, Epidemiologic Studies, Worker Notification, and Medical Surveillance at a Former Nuclear Weapons Facility

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&

U. S. Department of Energy

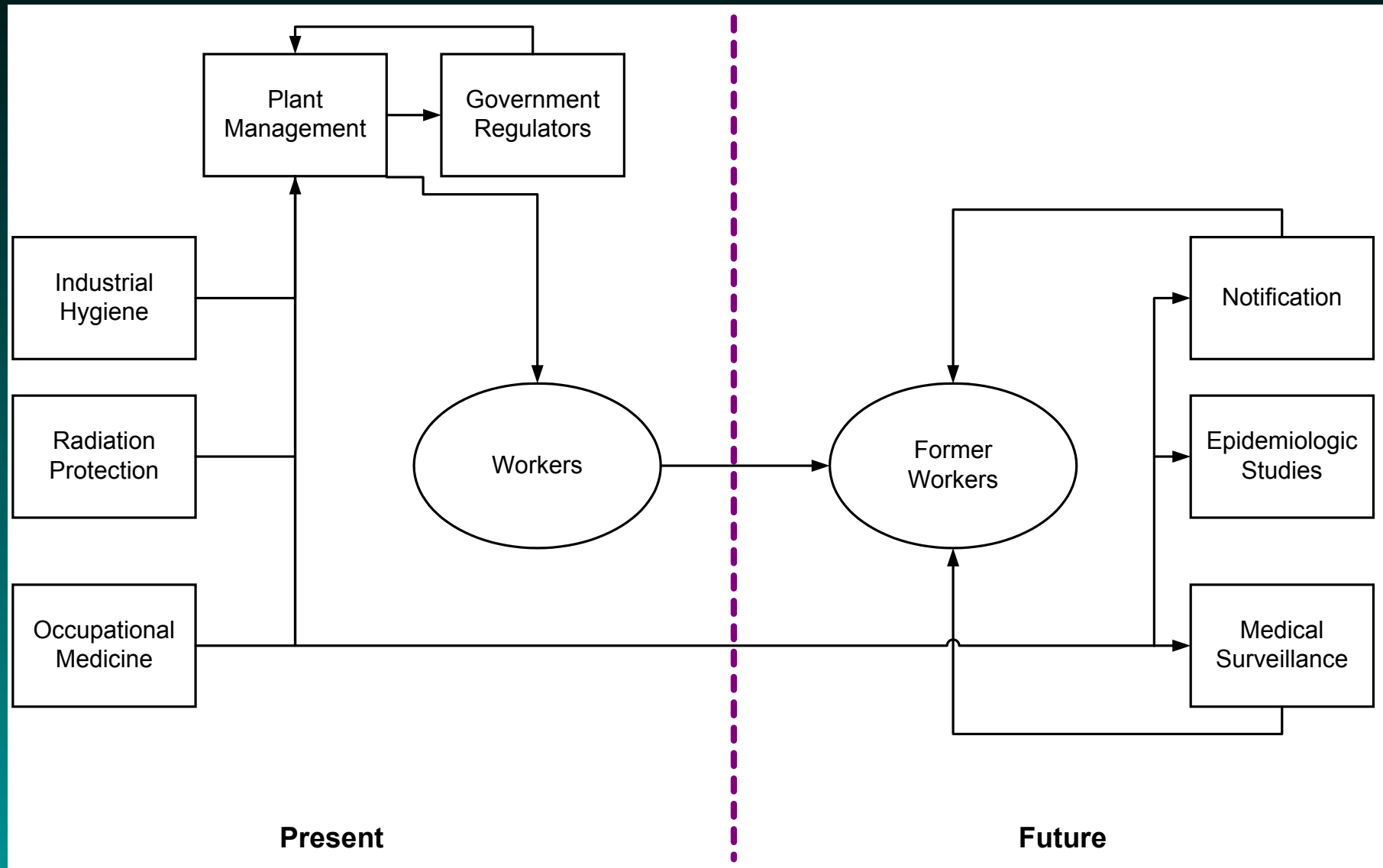
Acknowledgements

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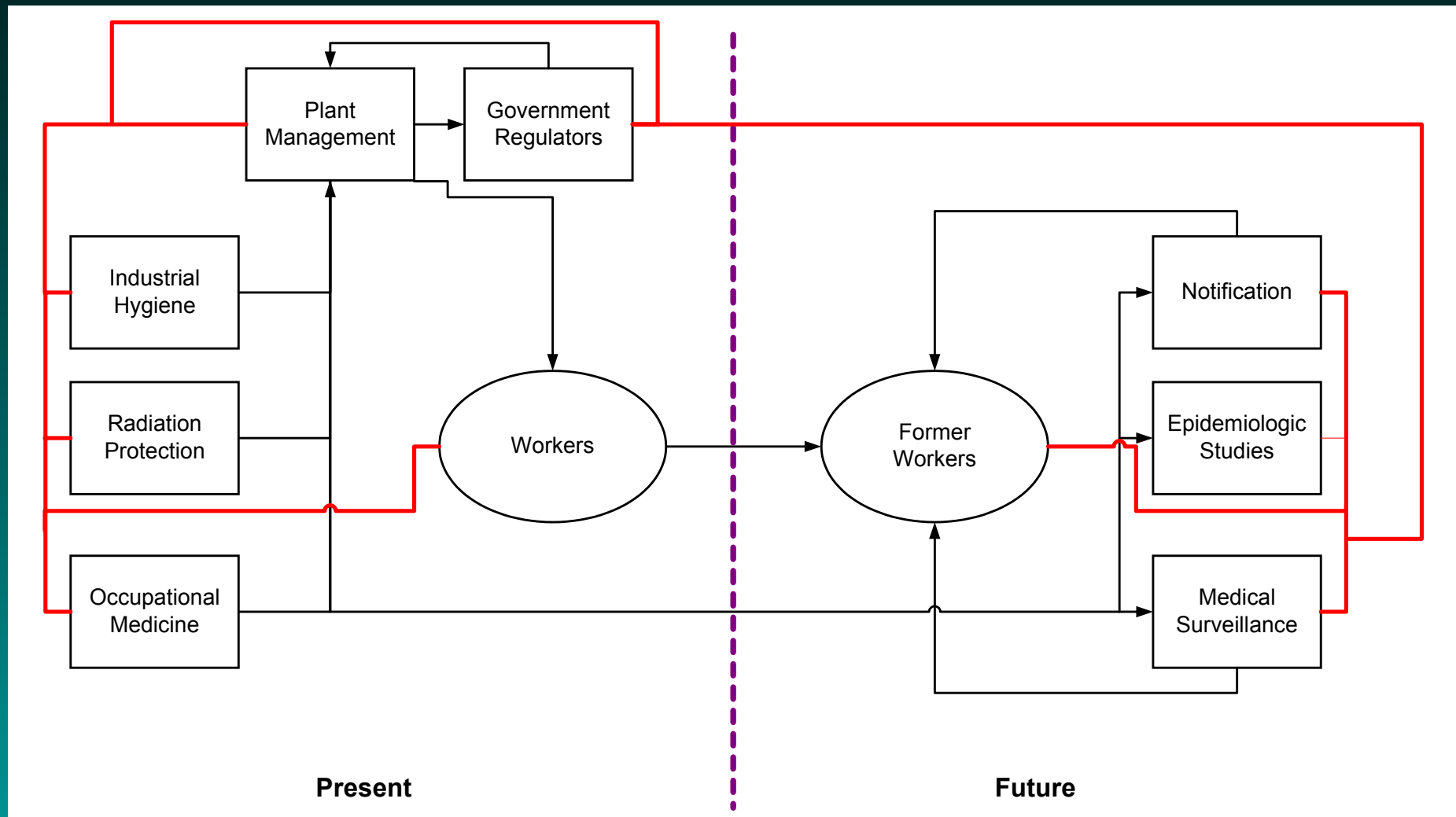
Exposure Surveillance Goal

To develop an efficient system for exposure data collection, management, and interpretation that encourages aggregate analyses of exposure data, identifies prevention and control strategies, and provides useful data for other health and safety purposes

Usual Workplace



Workplace with Exposure Surveillance and Epidemiology



Goals for Development of Exposure Database

- Easy to use
- Minimal daily time investment
- Time savings on routine tasks
- “Minimum” number of data elements
- Wide range of automated analyses
- Graphical data interpretations

Development Process

- Identification of key IH data “users” and “collectors”
- Focused meetings to identify core data elements
- System development by research staff IH and programmer
- Entry of past samples by research staff IH
- Testing by small number of company IH's
- Debug, debug, debug
- Program released for full use
- Continued maintenance and enhancement

Data Elements

- Sample Number/ Location Information
- Employee Information
- Exposure Modifiers
- Sampling Information
- Sample Results
- Work Descriptors

Sample Number/ Location Information

- Unique Sample Number
- Building
- Room
- Outside Locator
- Sample Date
- Hygienist ID

Employee Information

- Employee ID or SSN
- Employee Name
- Job Classification

Exposure Modifiers

- Respiratory Protection
- Engineering Controls
- Type of Work Area

Sample Information

- Sample Type
- Reason for Sample
- Consecutive Samples?
- Sampling Time
- Flow Rate
- Sample Volume

Sample Results

- Compound(s) Sampled
- Analytical Laboratory Results
- Units of Measurement
- Below Limit of Detection?
- Time Weighted Average Exposure (TWA)
- Eight-hour Time Weighted Average Exposure

Work Descriptors

- Work Type
- Task Group or Task
- Task Duration

Task Group Examples

- Decontamination: wet methods
- HEPA vacuuming
- Sorting, packaging, or repackaging
- Waste treatment
- Housekeeping
- Ventilation system maintenance

Work Type Variables

Work Type	ID	Task Group / Task
Cleanup	CU1.	Use of hand tools for size reduction, dis-assembly, etc.
	CU2.	Use of powered tools (e.g. Sawzall, drill) for size reduction, dis-assembly, etc.
	CU3.	Hot cutting or welding
	CU4.	Decon: Wet methods
	CU5.	Decon: Mechanical methods (e.g. dry wiping, sweeping)
	CU6.	HEPA Vacuuming
	CU7.	Abrasive methods (e.g. sanding, grinding, CO2 blasting)
	CU8.	Draining of pipe, tank, or other container
	CU9.	Coating removal (paint, adhesives, etc.)
	CU10.	Asbestos removal/abatement (including clearances samples)
	CU11.	On-site transport of waste materials
	CU12.	Materials consolidation
	CU13.	Sorting, packaging, or re-packaging waste materials
	CU14.	Demolition of buildings or other large structures
	CU15.	Environmental remediation
	CU16.	Miscellaneous--not covered by current coding choices
	CU17.	Polymer Macro-Encapsulation



Logistic Information

Employee

Exposure
Modifiers

Sample
Information

Sample
Results

Work
Descriptors

Logistic Information

Sample number:

Building:

Other if building is 000:

Room Number:

Record: 14 1 of 1

Date:

Hygienist ID:

Hygienist name:

Sequence number:

Report ID:

(List shows numbers previously used.)

Survey number:

Sample number:

Print Notification

☐

Peer reviewed

☐

Record: 14 1 of 1

Design Features

- Color-coded fields
- Automated calculations
- Self-building “pull-down” lists
- Automatically filled “confirmation” fields
- Complex validation rules
- Personnel roster from HR
- Chemical agent table including TLV’s and PEL’s
- Very few free-form text fields

Applicability

- Single analyte breathing zone samples
- Multiple analyte breathing zone samples
- Area samples
- Consecutive or multiple partial period samples
- Direct reading instrument samples
- Bulk samples
- Samples with multiple work tasks



Data Entry

Reports

Data Analysis

Choose Report:

All Samples by Building
Employee Notification
Exposure History
Exposures by Agent

Print

Reset All

Reset Empl. Notification

Choose Parameters:

All

Agents

All

Buildings

All

Employees

All

Work Packgs

All

Sample #'s

All

Report #'s

All

Hygienists

All

Job Titles

All

Job Exp. Cat.'s

All

Work Types

All

Task Groups

May 1998

May

1998

S	M	T	W	T	F	S
26	27	28	29	30	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6

Threshold Level:

No Threshold

Start Date:

3/30/95

Set

Custom Header:

End Date:

1/16/98

Set

EXIT

Report Generation

- Employee notification reports
- Medical surveillance reports
- Automated sample reports
- Contaminant levels by any combination of the following factors:
 - Building
 - Date
 - Employee
 - Type of contaminant
 - Work type
 - Task or Task group

Filters and Queries

- Date
- Sample type
- Threshold Level in % of PEL
- Work type or task
- Building
- Employee
- Job title
- Work package
- Industrial hygienist
- Chemical agent

Query Example

- All beryllium samples
 - between 8/15/94 and 7/3/96
 - in building 189
 - on electricians
 - doing facilities maintenance work
 - where the 8-hour TWA $>$ 10% of the PEL

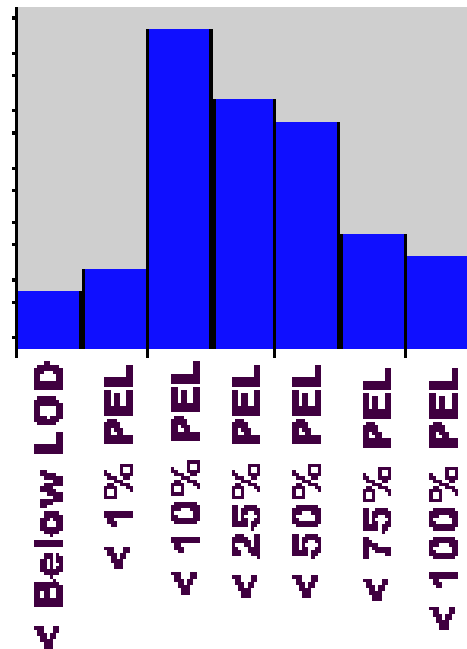
Data Analysis

- Average exposure levels by work task
- Distributions of exposure levels
- Average exposure levels relative to the PEL's
- Exposure levels stratified by Work Packages
- Exposure stratification by location

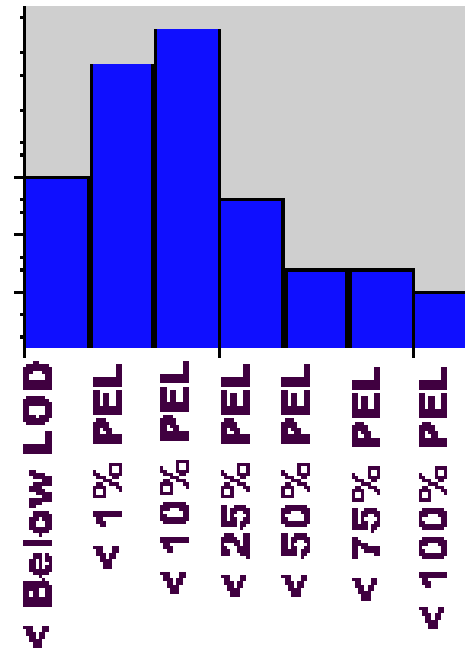
Distribution Analysis

Breathing Zone Sample Distributions by Building

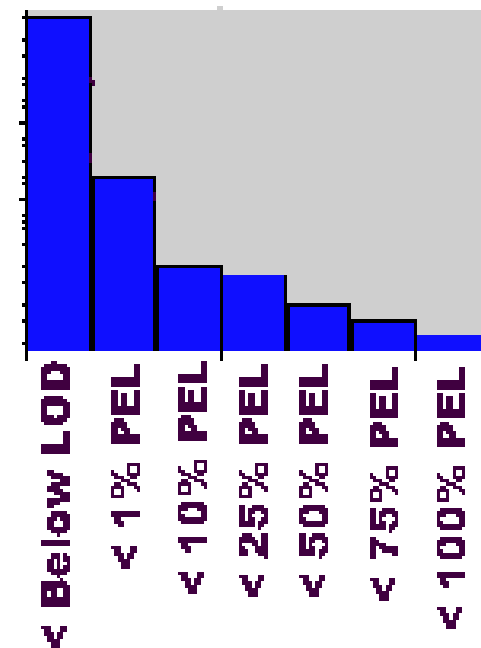
Building ZZZ



Building YYY



Building XXX

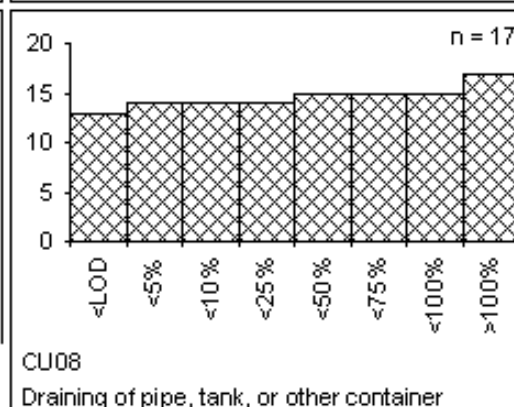
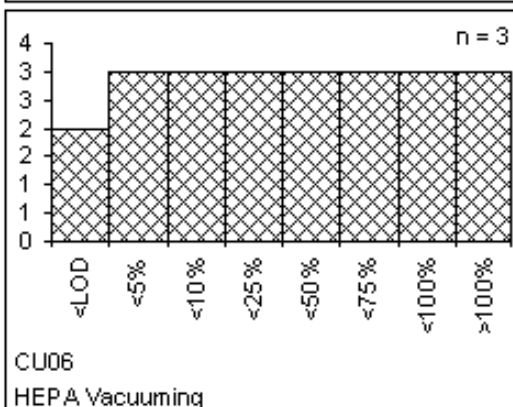
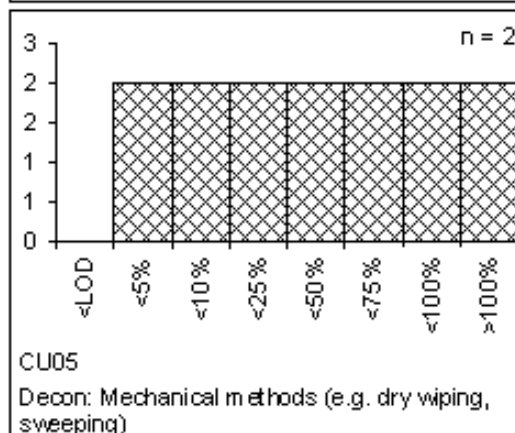
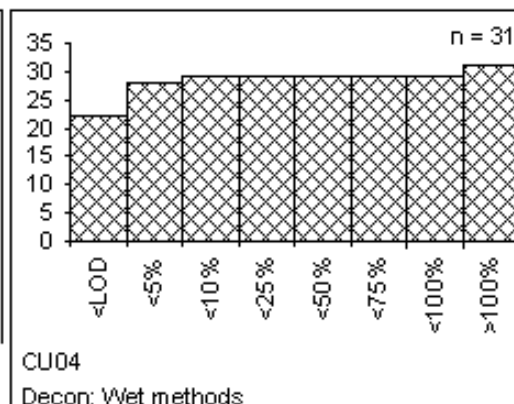
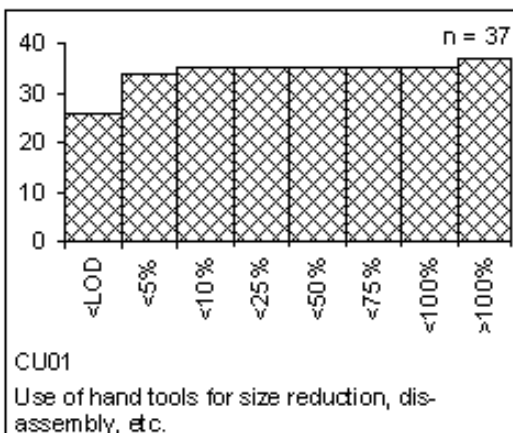
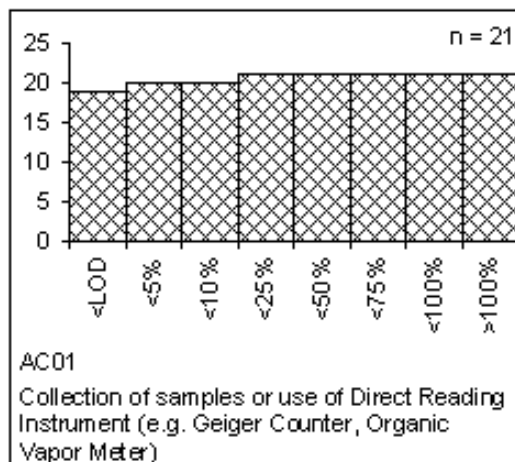


Analysis by Task

Beryllium Exposures by Task

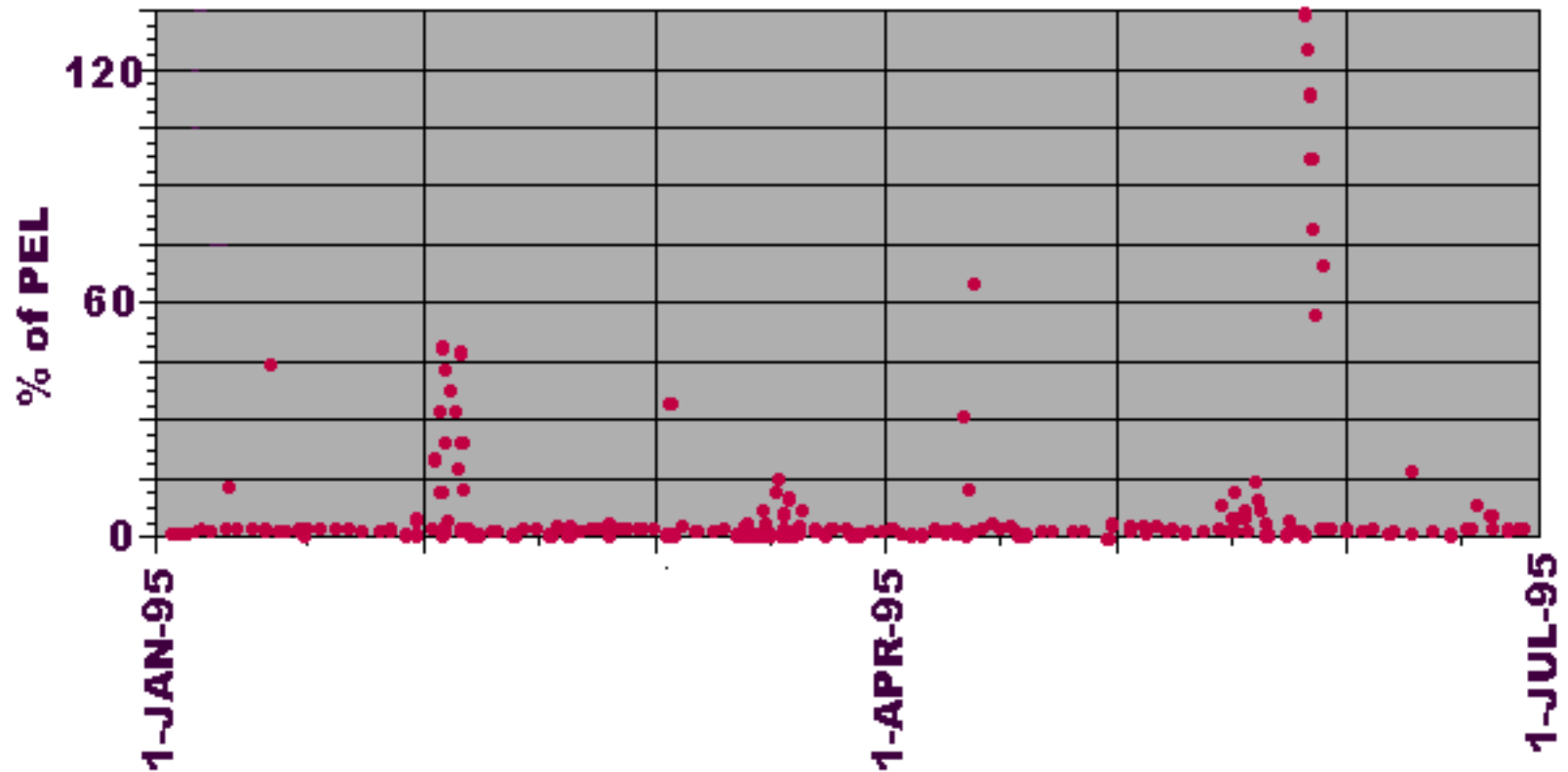
(3/30/95 - 8/18/98)

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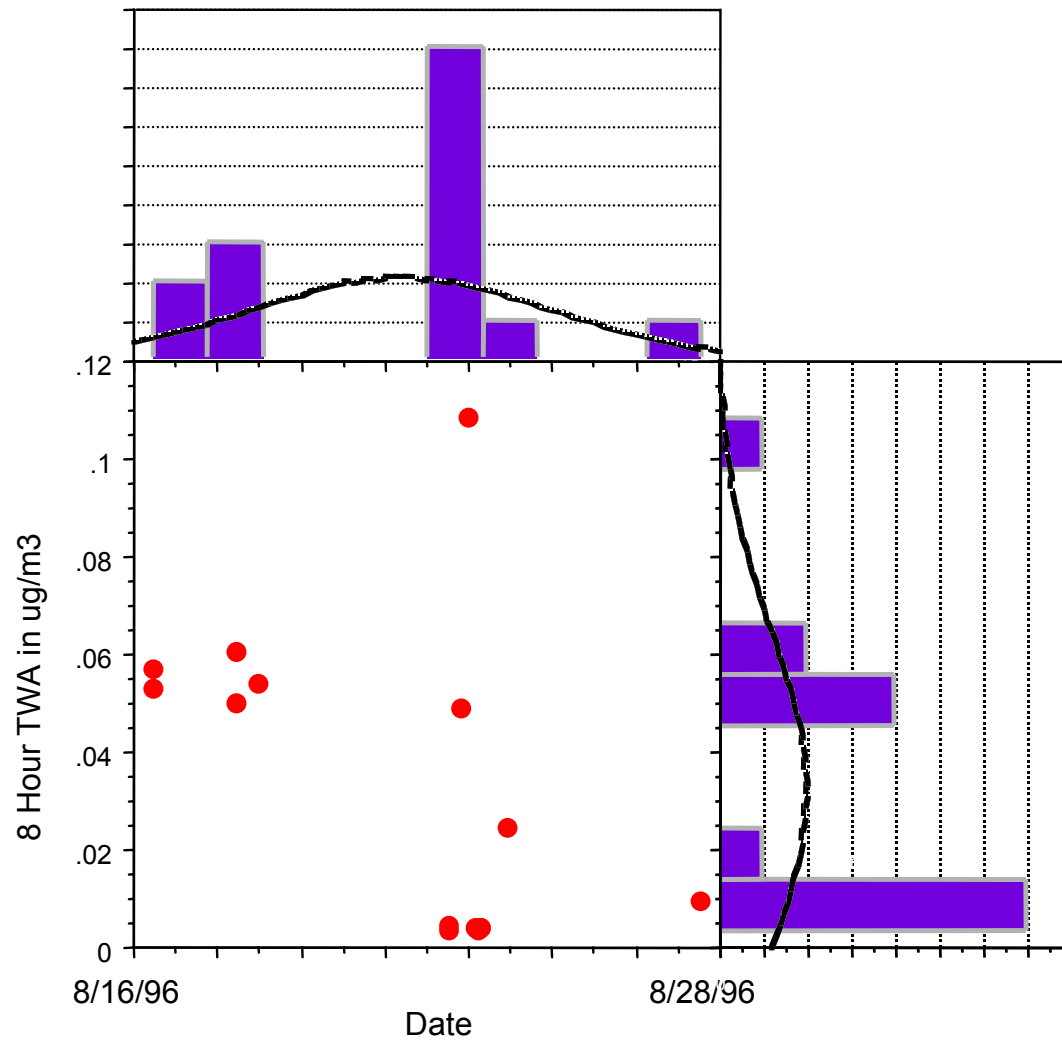


Time Series Analysis

Beryllium Air Samples by Date



Employee Exposure Profiles



Utility

- Automated performance feedback
- Exposure profiles for medical surveillance providers
- Documentation for changes in monitoring strategies
- Identification of inefficient engineering controls
- Identification of “high exposure” work tasks
- H&S data for work planning insight

Web Page

[http://www.bernardino.colostate.edu/
oedb/oedb.html](http://www.bernardino.colostate.edu/oedb/oedb.html)

Occupational Exposure Database Documentation Page

This page is dedicated to providing you with information regarding the development and implementation of an occupational exposure database and surveillance system at the Rocky Flats Environmental Technology Site (RFETS).

The project itself was funded by the National Institute for Occupational Safety and Health (NIOSH) Grant R01/CCR 812044-01.

Project Participants:

- ◆ [A. James Rutenber](#), M.D., Ph.D., University of Colorado Health Sciences Center, Department of Preventive Medicine and Biometrics
- ◆ [Anthony D. LaMontagne](#), Sc.D., Center for Community-Based Research, Dana Farber Cancer Institute
- ◆ [Michael V. Van Dyke](#), M.S., Tri-County Health Department, Commerce City, Colorado
- ◆ [John W. Martyny](#), Ph.D., CIH, Tri-County Health Department, Commerce City, Colorado

- ◆ Slides from presentation: Development of an Exposure Database and Surveillance System for Use by Practicing OSH Professionals. International Symposium on Occupational Exposure Databases and Their Application for the Next Millennium. London, England. November 1, 1999. ([Download in Powerpoint format](#))
- ◆ Demonstration copy of Occupational Exposure Database developed for RFETS ([Download zipped file in MS Access 97 format](#))
- ◆ Documentation of database ([Download a Zipped file in MS Word 97 format](#))

Supporting Publications:

La Montagne, A.D., Herrick, R.F., Van Dyke, M.V., Martyny, J.W., Rutenber, A.J. Exposure databases and exposure surveillance: promise and practice. *Am Industr Hyg Assoc J* (in review).

LaMontagne, A.D., Rutenber, A.J., Wegman, D.H., Exposure surveillance for chemical and physical hazards. In *Workplace Epidemiologic Surveillance: Principles and Practice* (Maizlish, N. ed.) London: Oxford University Press (in press).

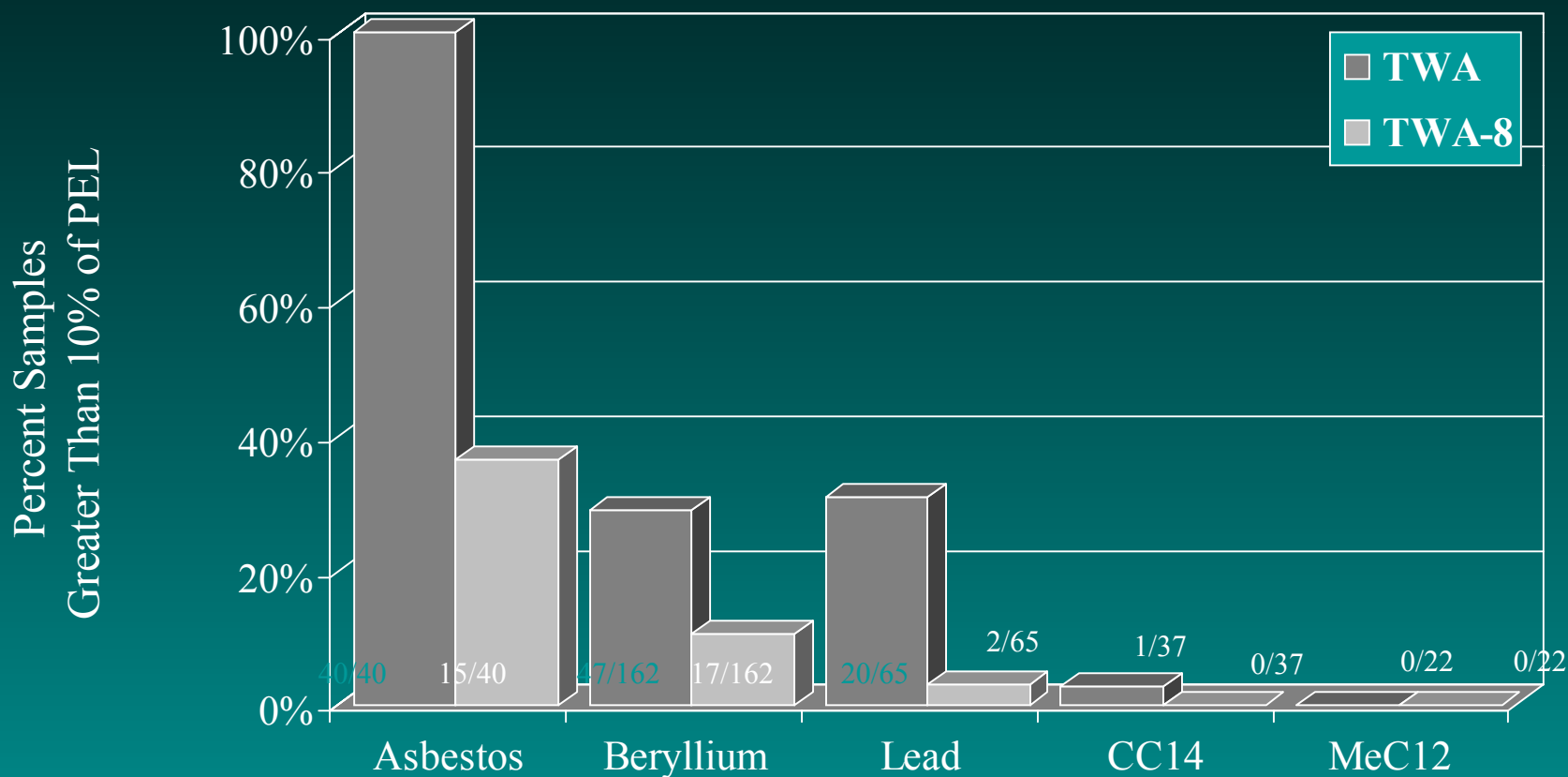
LaMontagne, A.D., Van Dyke, M.V., Martyny, J.W., Simpson, M.W., Holwager, L.A., Clausen, R.M., Rutenber, A.J. Development and

Breathing Zone Sample Frequencies by Compound Measured

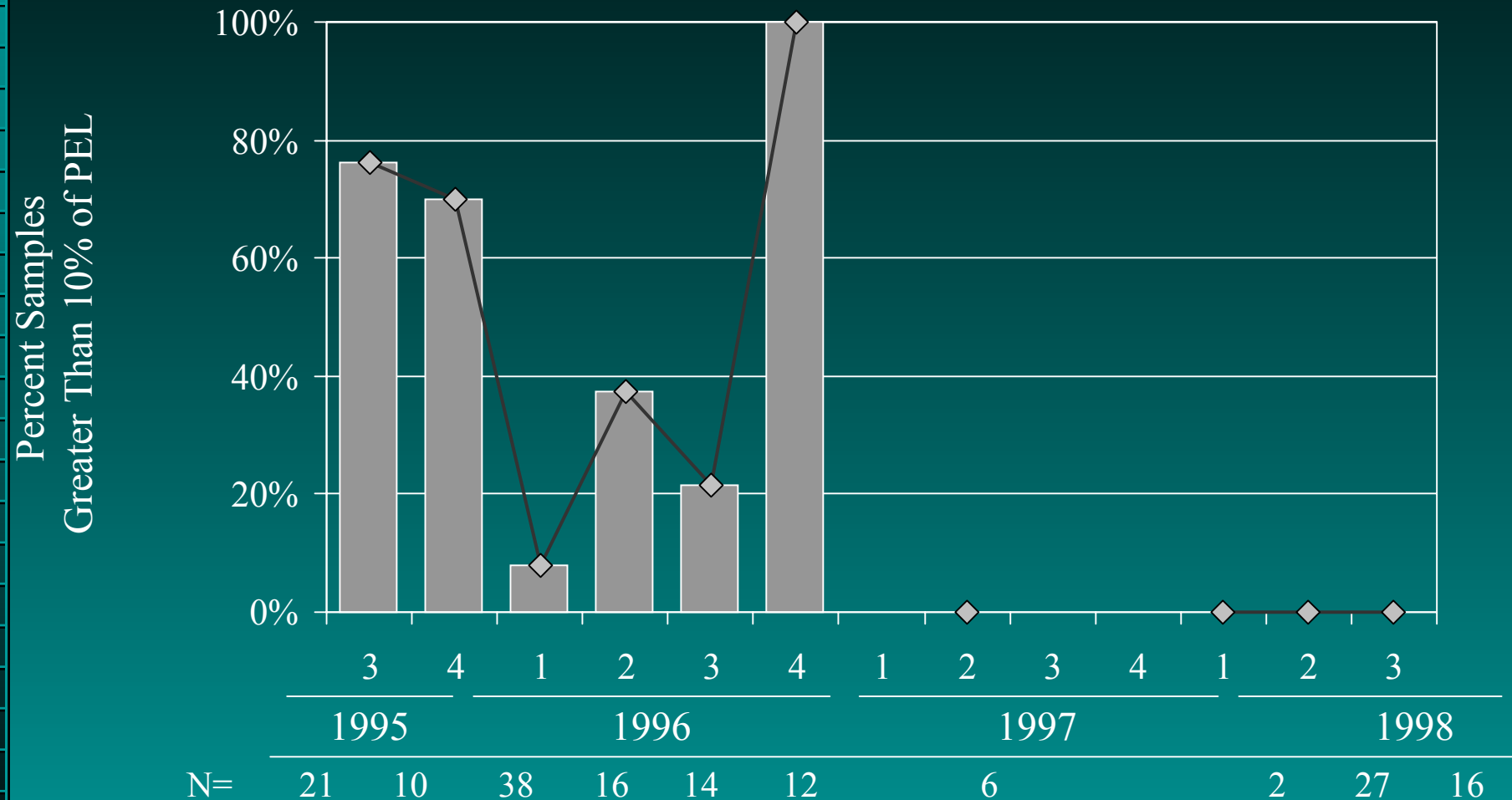
Compound	Frequency	Percent
1,1,2-Trichloro-1,2,3-Trifluoroethane	22	2.6
1,2-Dichloroethane	22	2.6
Acetone	22	2.6
Asbestos	44	5.1
Benzene	22	2.6
Beryllium and beryllium compounds (as Be)	167	19.4
Cadmium, total (as Cd)	10	1.2
Carbon tetrachloride	36	4.2
Chloroform	22	2.6
Chromium, hexavalent insoluble	29	3.4
Cyclohexane	22	2.6
Di-sec octyl phthalate	3	0.3
Ethyl acetate	22	2.6
Ethyl benzene	22	2.6
Ethyl ether	22	2.6
Ethylene dichloride	22	2.6
Iron oxide dust & fume (Fe ₂ O ₃) (as Fe)	2	0.2
Lead, inorganic (as Pb)	65	7.6
Methyl alcohol	11	1.3
Methyl chloroform	22	2.6
Methyl ethyl ketone	22	2.6
Methylene chloride	22	2.6
Nickel, metal (as Ni)	1	0.1
Nickel, soluble compounds (as Ni)	1	0.1
Particulates not otherwise classified	3	0.3
Perchloroethylene	22	2.6
Pyridine	22	2.6
Refractory ceramic fibers	2	0.2
Selenium compounds (as Se)	17	2.0
Silica - crystalline, cristobalite (as quartz, respirable)	5	0.6
Silica - crystalline, quartz (as quartz, respirable)	5	0.6
Silica - crystalline, tridymite (as quartz, respirable)	5	0.6
Soda Ash (PNOC) (Total)	2	0.2
Toluene	22	2.6
Trichloroethylene	22	2.6
Trimethyl benzene	22	2.6
Vinyl chloride	11	1.3
Vinylidene chloride	22	2.6
Xylenes (o-, m-, and p- isomers)	22	2.6
Total	859	100.0

TWA Samples Greater Than 10% of PEL

By Agent, TWA Normalized to Sampling Period versus 8 Hours (1995-1998)

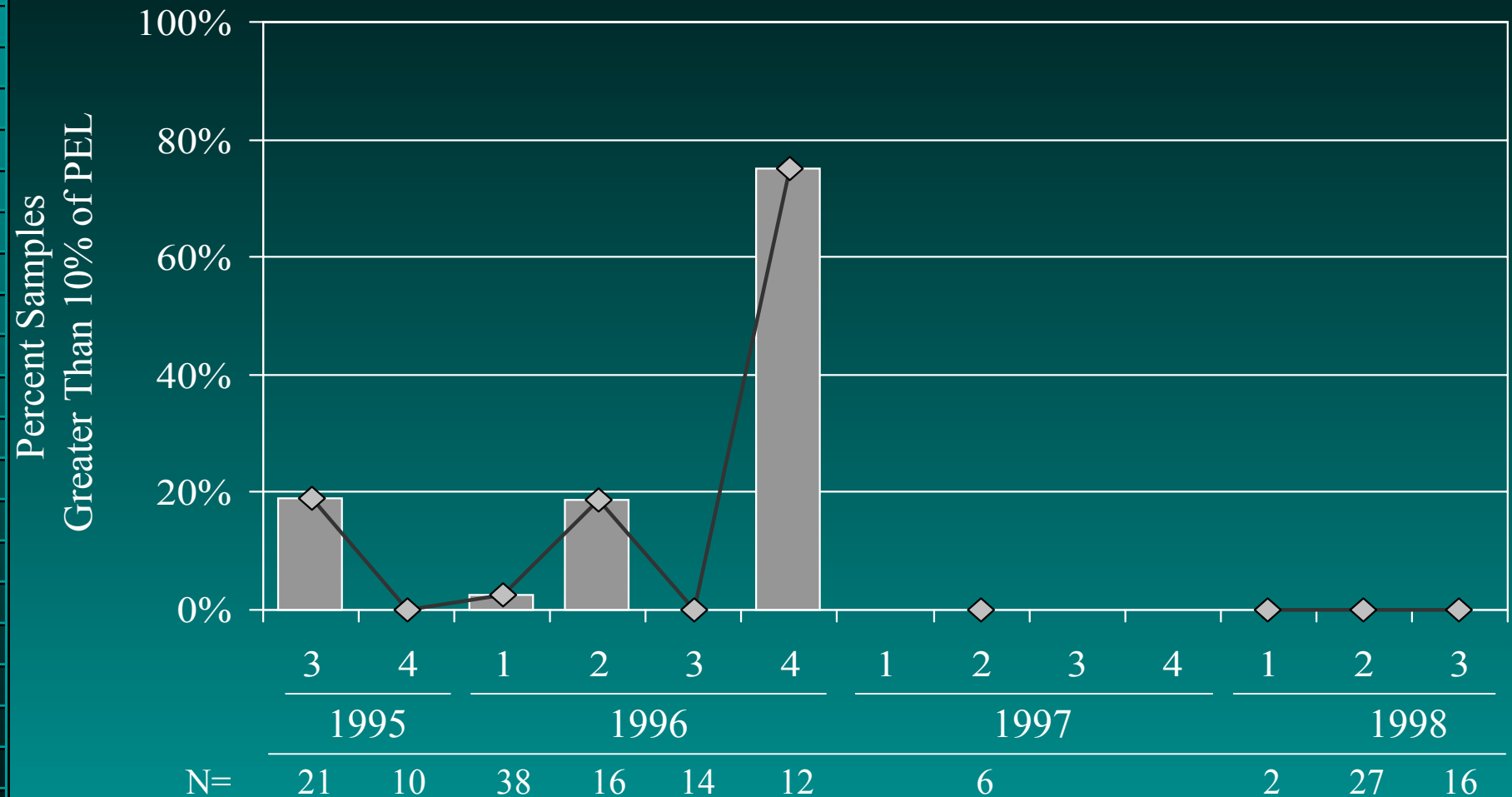


Percent Beryllium Personal BZ Samples > 10% of PEL By Year & Quarter, Unadjusted TWA



Percent Beryllium Personal BZ Samples > 10% of PEL

By Year & Quarter, TWA-8



Medical Surveillance

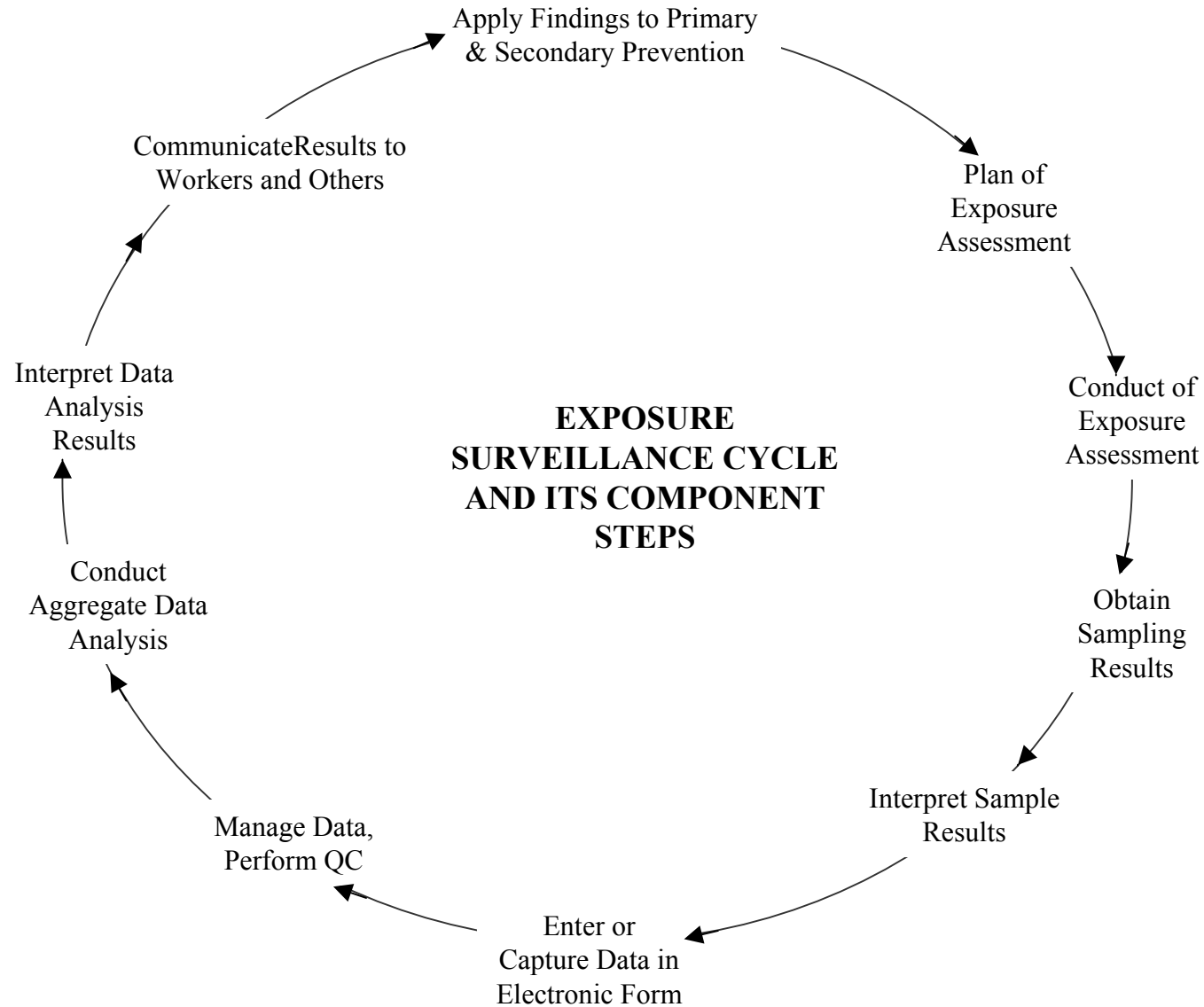
Table 5. FILTERING FOR MEDICAL SURVEILLANCE REQUIREMENTS

Agent	Total Personal Breathing Zone Samples (1995-1998)	TWA-8 Medical Surveillance Criteria	Number of Employees Above Criteria (# of samples per employee)
Asbestos	40	0.1 f/cc [*]	0
Beryllium	162	0.5 mcg/cu m ^{**}	7 (1), 1 (2)
Lead	65	30 mcg/cu m [*]	1 (1)
Methylene Chloride	22	12.5 ppm [*]	0

^{*} From OSHA standards

^{**} From proposed DOE beryllium rule.[DOE, 1998 #201]

Exposure Surveillance Cycle



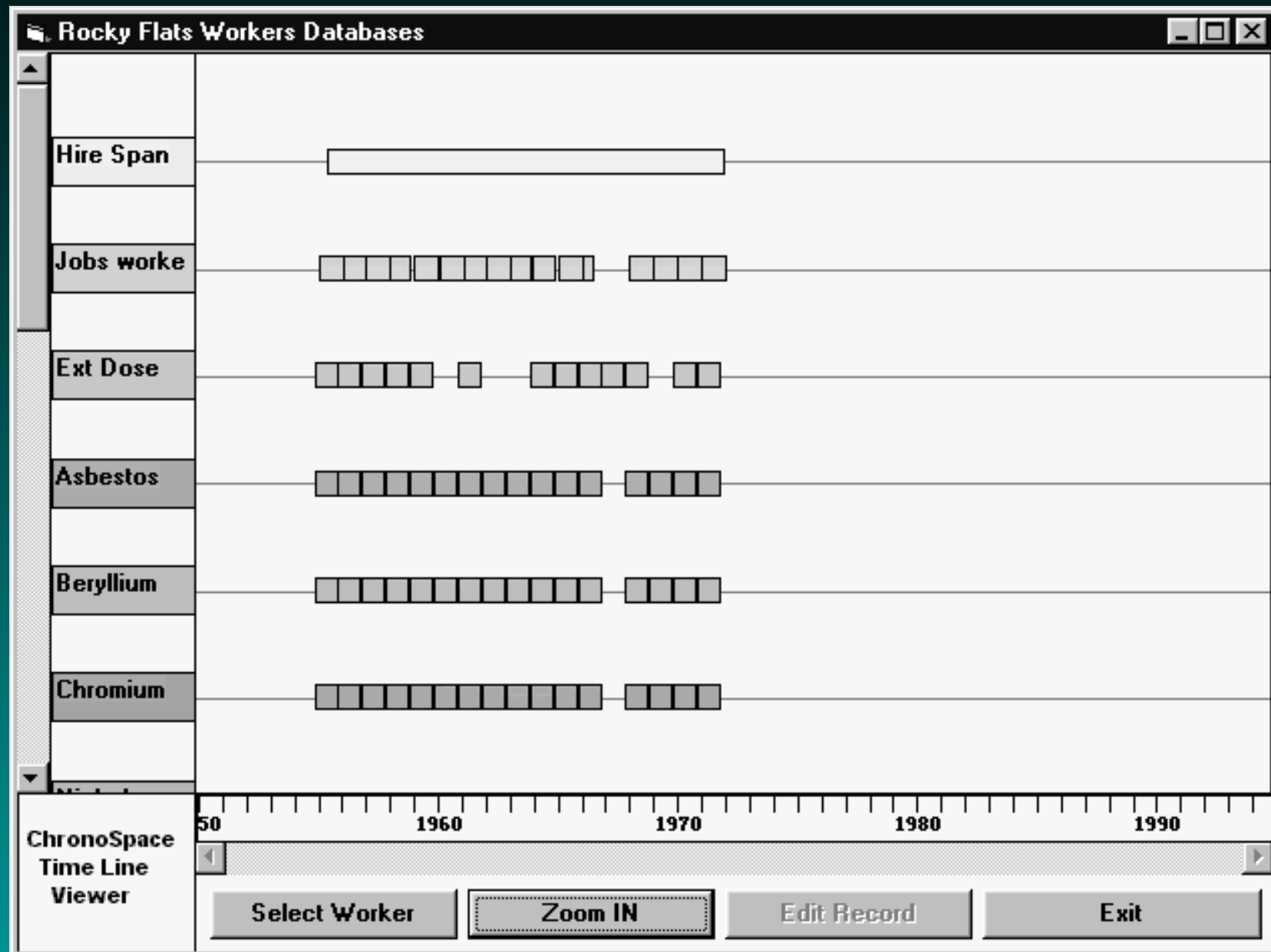
Time Line for Exposure Data System Development

- 9/95–11/97 Pilot projects
- 12/97–3/97 Identification of data elements
- 3/97–6/97 Programming Access database and front end
- 7/97–7/99 Field test with single contractor
- 7/97–7/98 Database and front end revisions, develop reporting and analysis capabilities
- 12/98–6/99 Development of Oracle database with three contractors
- 7/99–present System operational site wide; generates individual exposure reports; used for PPE/control decisions for specific buildings

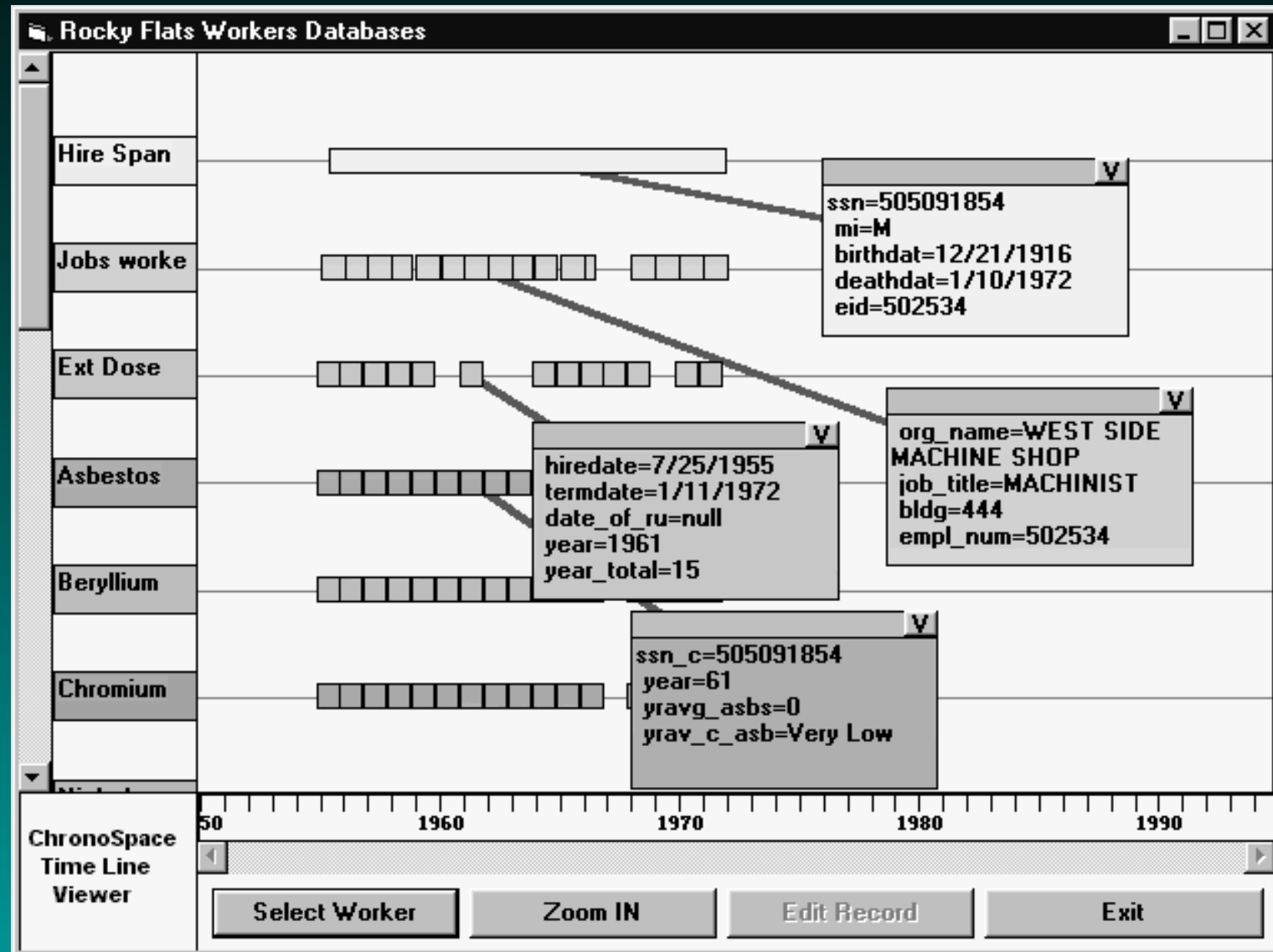
Failures of Exposure Data System

- Task data are not collected
- No report features in Oracle
- Database system requires IT department to operate
- DOE and prime contractor have no interest in surveillance
- No links to occupational medicine
- No surveillance for radiation exposures—only compliance reporting

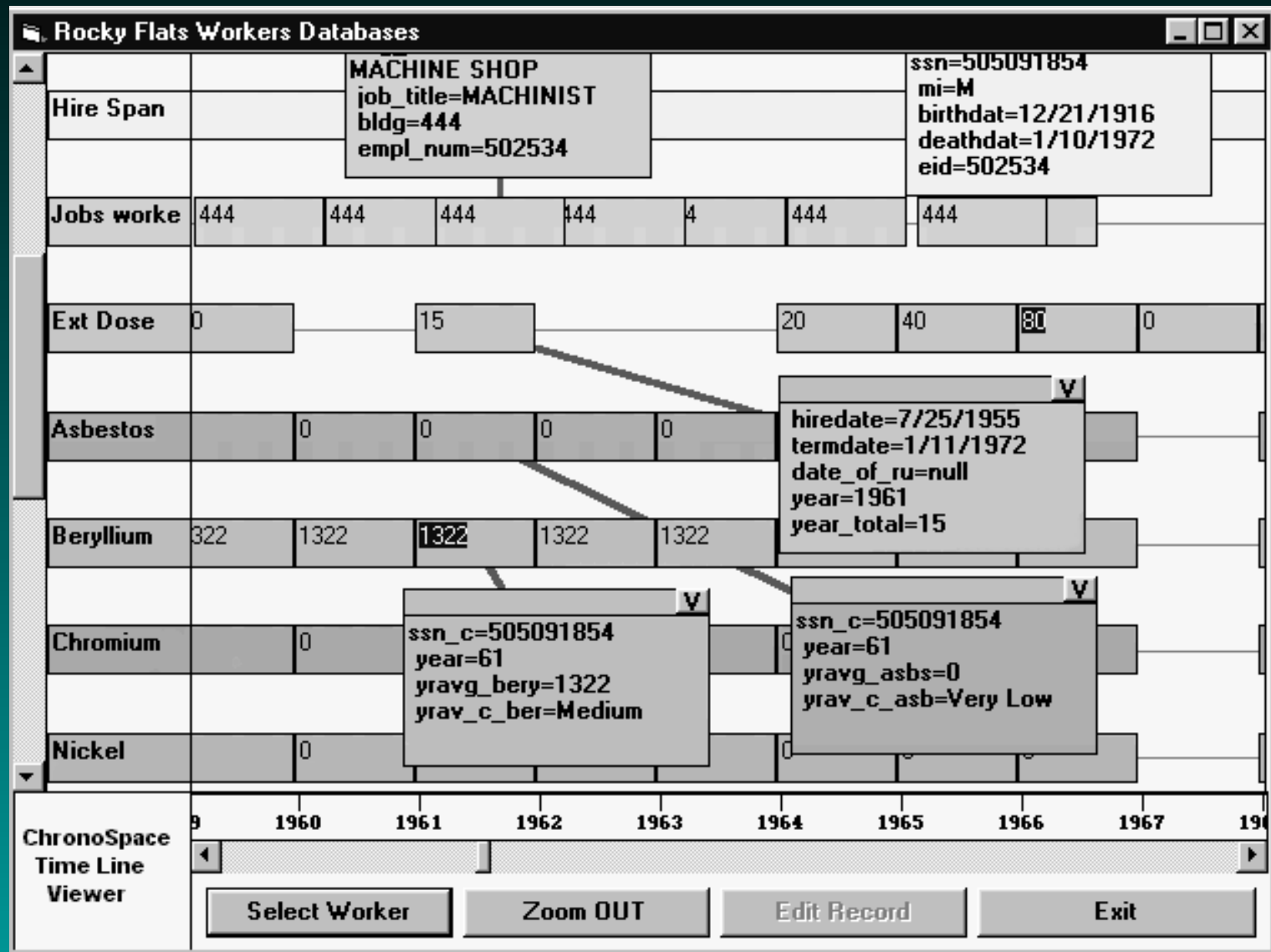
Time-Line Display of Job Exposure Matrix



Time-Line Display of Job Exposure Matrix—More Detail



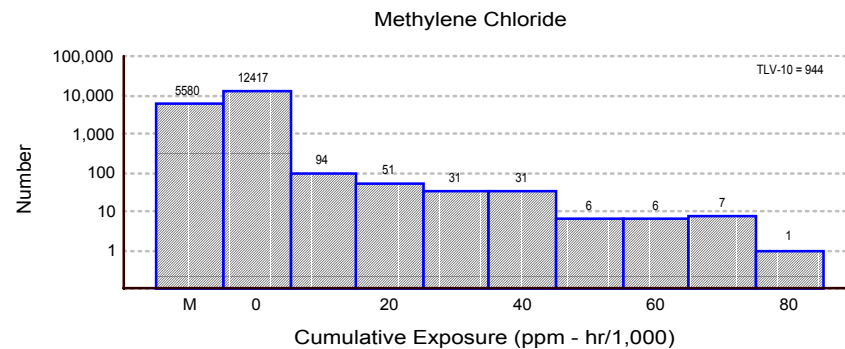
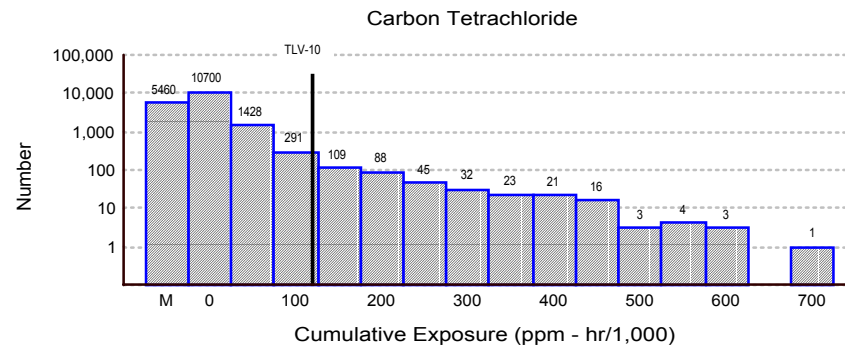
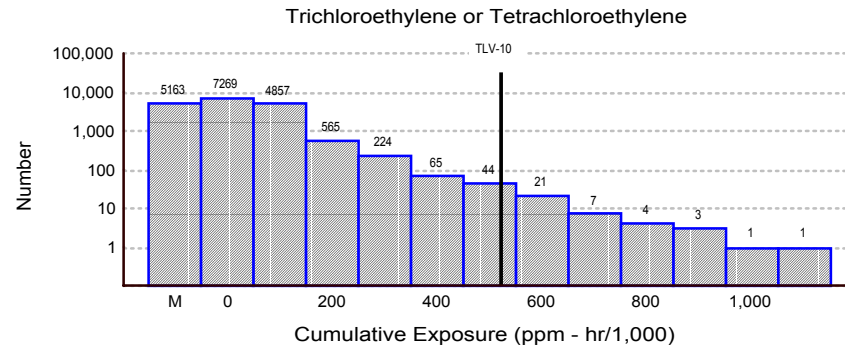
Time-Line Display of Job Exposure Matrix— Zoom Feature Activated



Job Exposure Matrix

- Monthly job and building assignments for 13,480 production workers (113,777 annual entries)
- 20 buidings, 8,740 organization codes, 4,308 job titles, 10 chemicals

Chemical Exposures from JEM



Exposure History for Individual Worker

example			Rocky Flats Job and Exposure History										Very Low	Low	Medium	High
Empl Num 520965 SSN 353744779 Last Name MCCREA First Name JASON																
Year	Bldg	Job Title	Asbestos	Be	Carbon Tet	Chrom	Formaldehyde	Lead	Methylene Chloride	Nickel	Perchlor	Trichlor	Noise	wore hearing protection?		
59	881	MACHINIST												<input type="checkbox"/>		
60	334	MACHINIST												<input type="checkbox"/>		
61	444	MACHINIST												<input type="checkbox"/>		
63	881	MACHINIST												<input type="checkbox"/>		
64	881	MACHINIST												<input type="checkbox"/>		
65	UXB	PROD MACHINIST												<input type="checkbox"/>		
66	444	PROD MACHINIST												<input type="checkbox"/>		
67	334	JRNYMN MACHINIST												<input type="checkbox"/>		
68	334	JRNYMN MACHINIST												<input type="checkbox"/>		
69	334	JRNYMN MACHINIST												<input type="checkbox"/>		
70	881	JRNYMN MACHINIST												<input type="checkbox"/>		
71	881	JRNYMN MACHINIST												<input type="checkbox"/>		
72	881	JRNYMN MACHINIST												<input type="checkbox"/>		
73	779	JRNYMN MACHINIST												<input type="checkbox"/>		
74	779	JRNYMN MACHINIST												<input type="checkbox"/>		
75	779	MACHINIST												<input type="checkbox"/>		

Exposure Comparisons for Worker Notification

Exposure Comparison Guide

level to the given

This report shows job titles in the same building at each exposure

chemicals.

EID: 000000

First name: JOHN

Last name: DOE

This report is for building Unknown

Asbestos

Very Low

High

ADMIN / WASTE
PIPEFITTER / MAINT
SERVICE ATTN / UTILITIES
CARPENTER / UTILITIES
COORD / ADMINISTRATION
METALLURGIST / FOUNDRY

Low

MECHANIC-CL / TRUCK & LABOR
TOOL GRINDER / MACHINING
PROC OP-CL / FOUNDRY

Medium

CARPENTER / ASSEM & TEST
CARPENTER / MAINT
CARPENTER / UTILITIES

Beryllium

Very Low

High

GLASS / MAINT
ASSEMBLER / ASSEM & TEST
ELEC ENG / MAINT
CLERK PACKER / INSPECTION
ENVIR SPLST / ENVIRONMENT
CLERK PACKER / PRODUCTION

Low

EXP OP / METALLURGY
MACHINIST / FABRICATION
SCIENTIST / METALLURGY

Medium

WELDER / BERYLLIUM
MACHINIST / INSPECTION
METALLURGIST / FABRICATION

Carbon Tetrachloride

Very Low

High

PROC OP / ADMINISTRATION
CHEMIST / HP
ELEC ENG / TECH SUPP
PROD WELDER / ASSEM & TEST
TOOL ENG / MACHINING
WELDER / ASSEM & TEST

Low

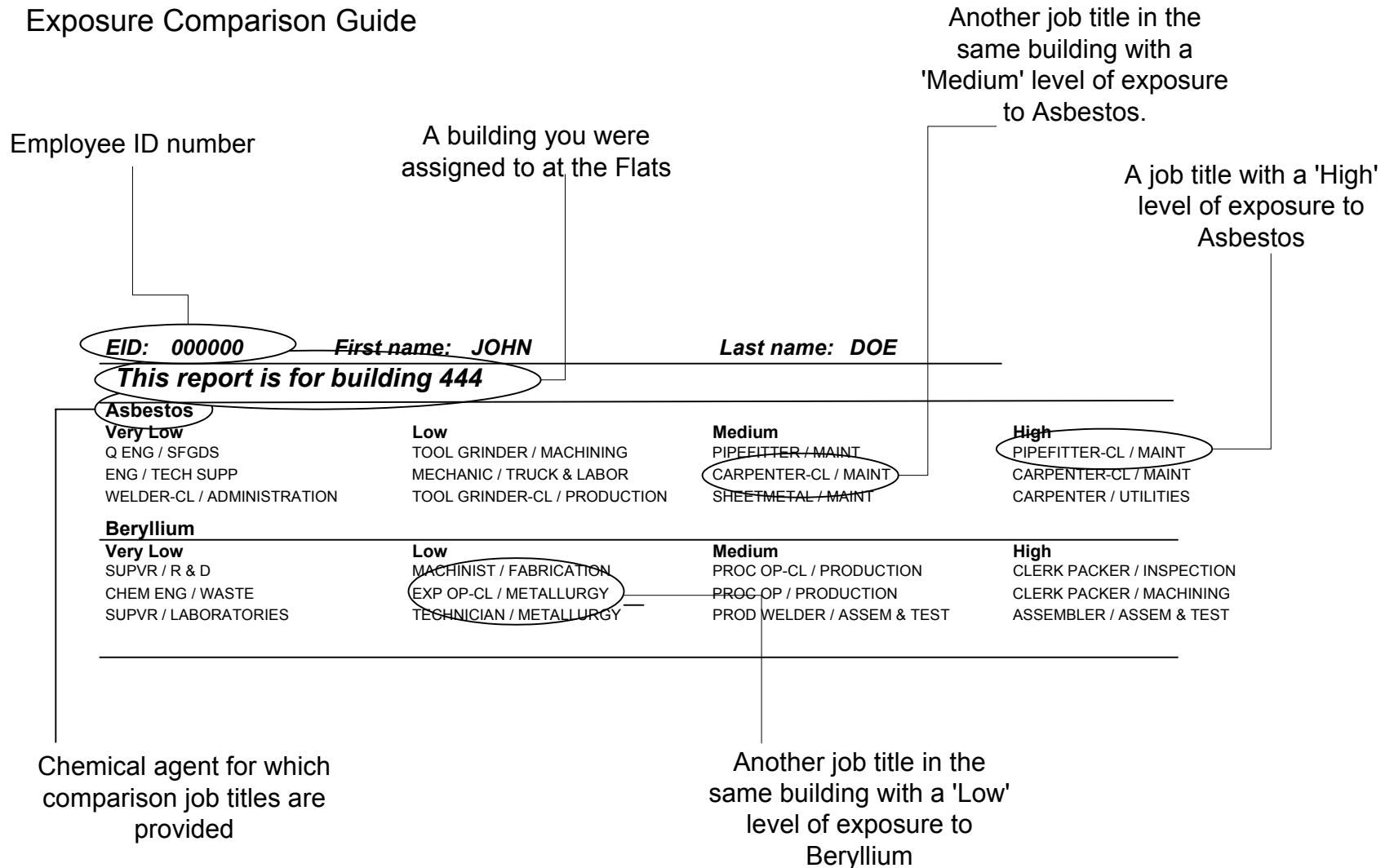
CARPENTER / MAINT
PROC OP / WASTE
TECHNICIAN / WASTE

Medium

CLERK PACKER / PRODUCTION
MONITOR-CL / HP
MAT ANALYST-CL / ASSEM & TEST

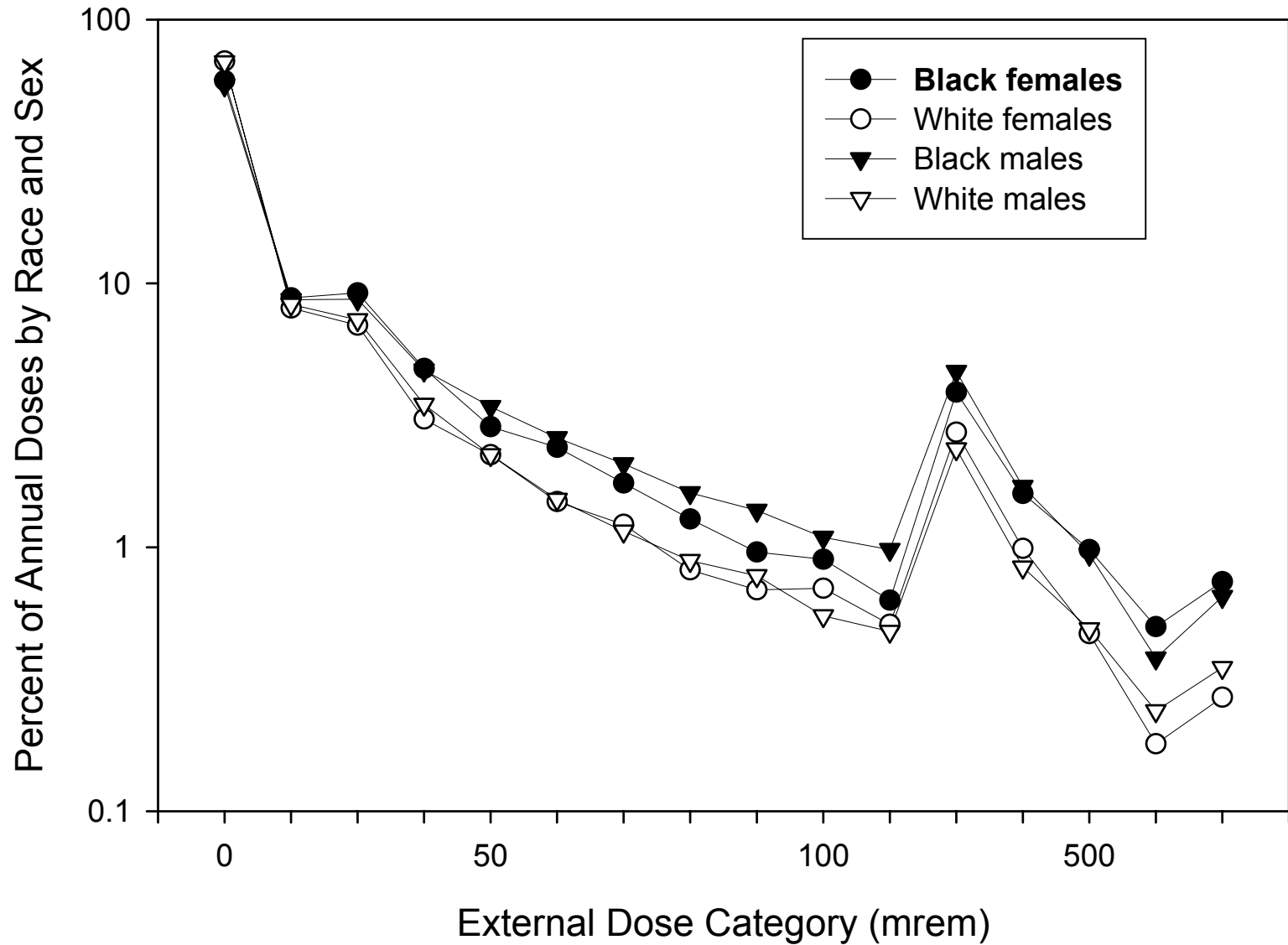
Additional Instructions for Reviewing and Correcting

Exposure Comparison Guide

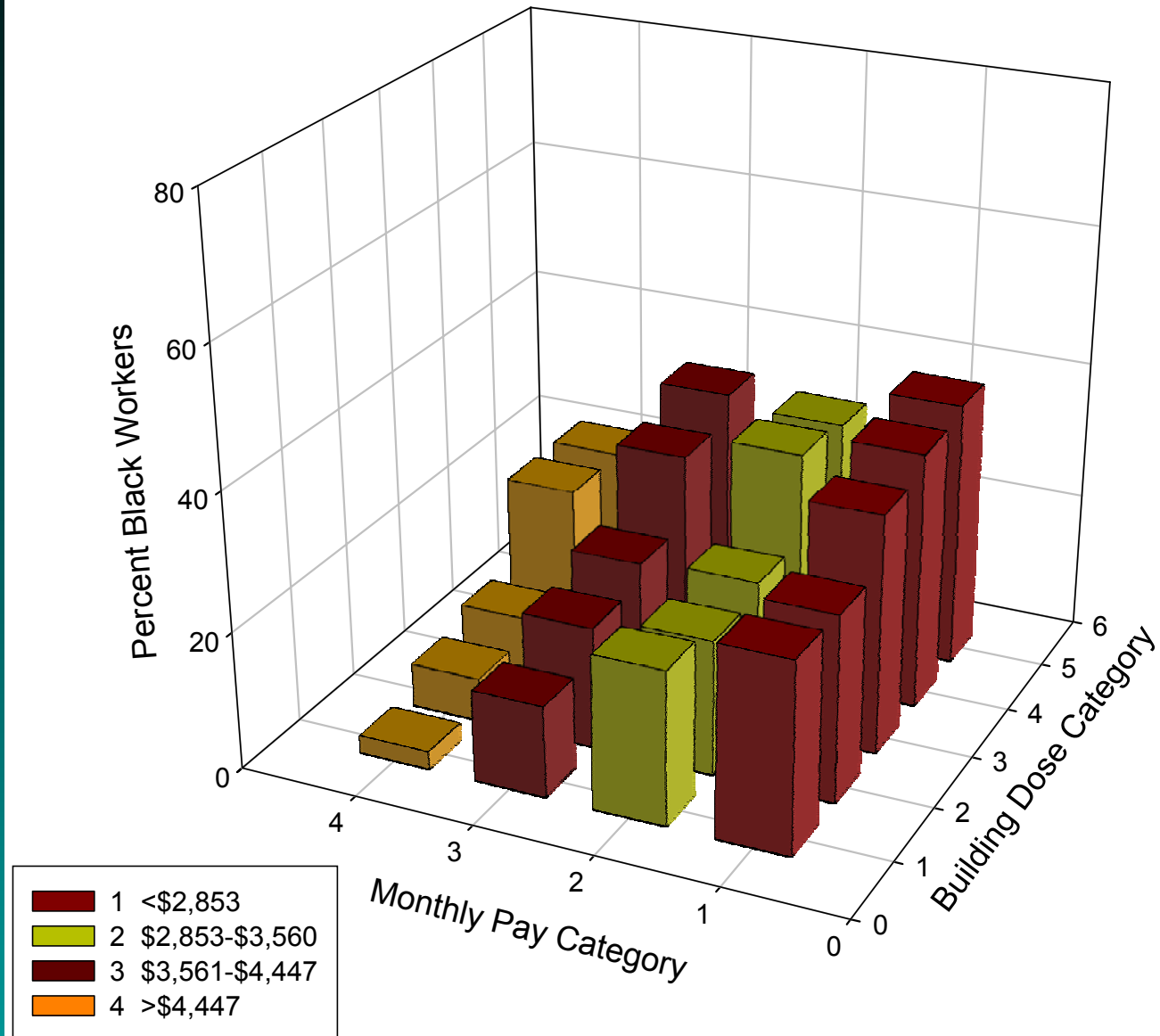


One job title may have different levels of exposure to the same chemical. This represents changes in the exposure level of the chemical over time.

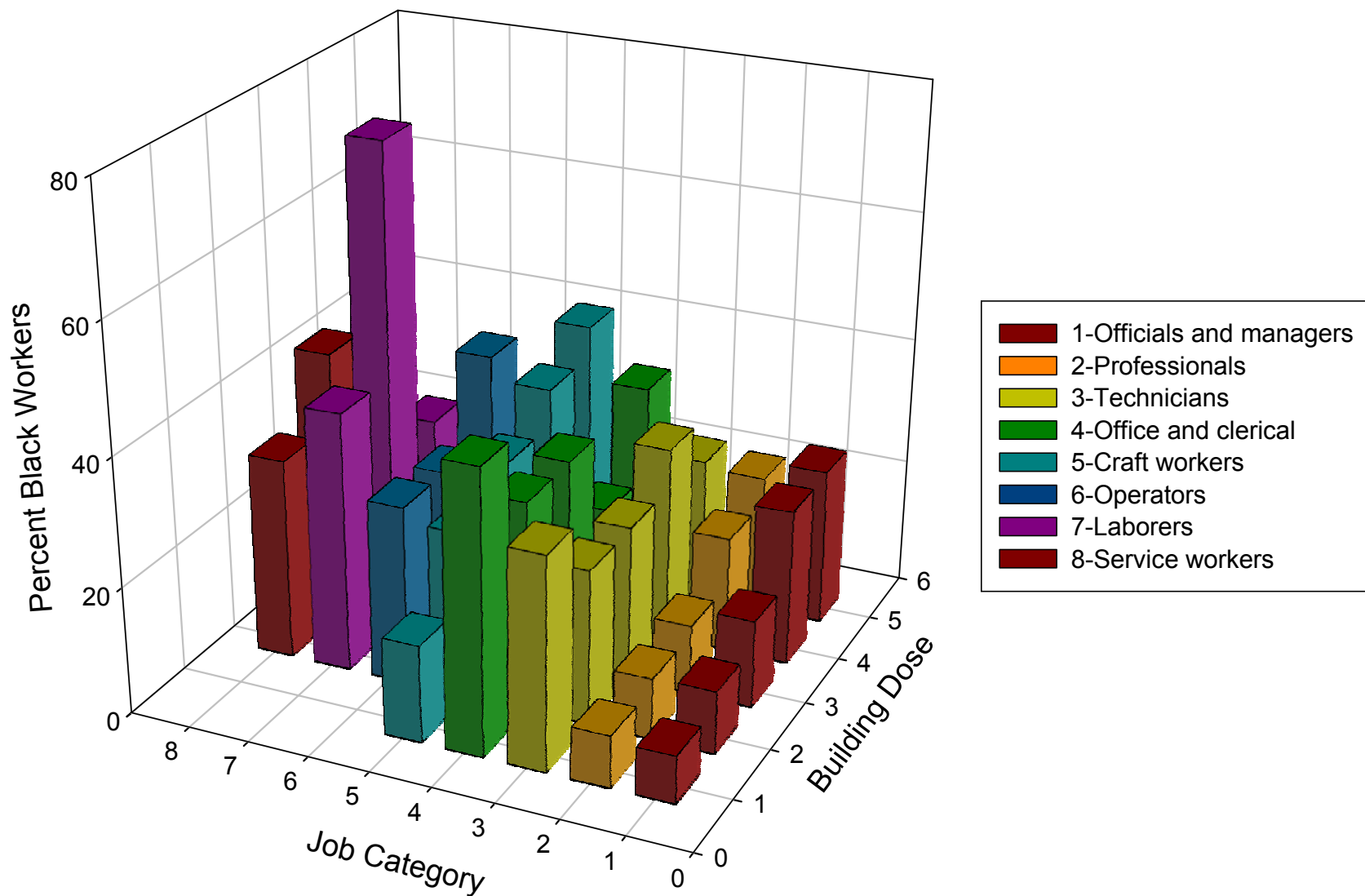
Distribution of Annual External Radiation Doses by Race and Sex Savannah River Site, 1991-1998



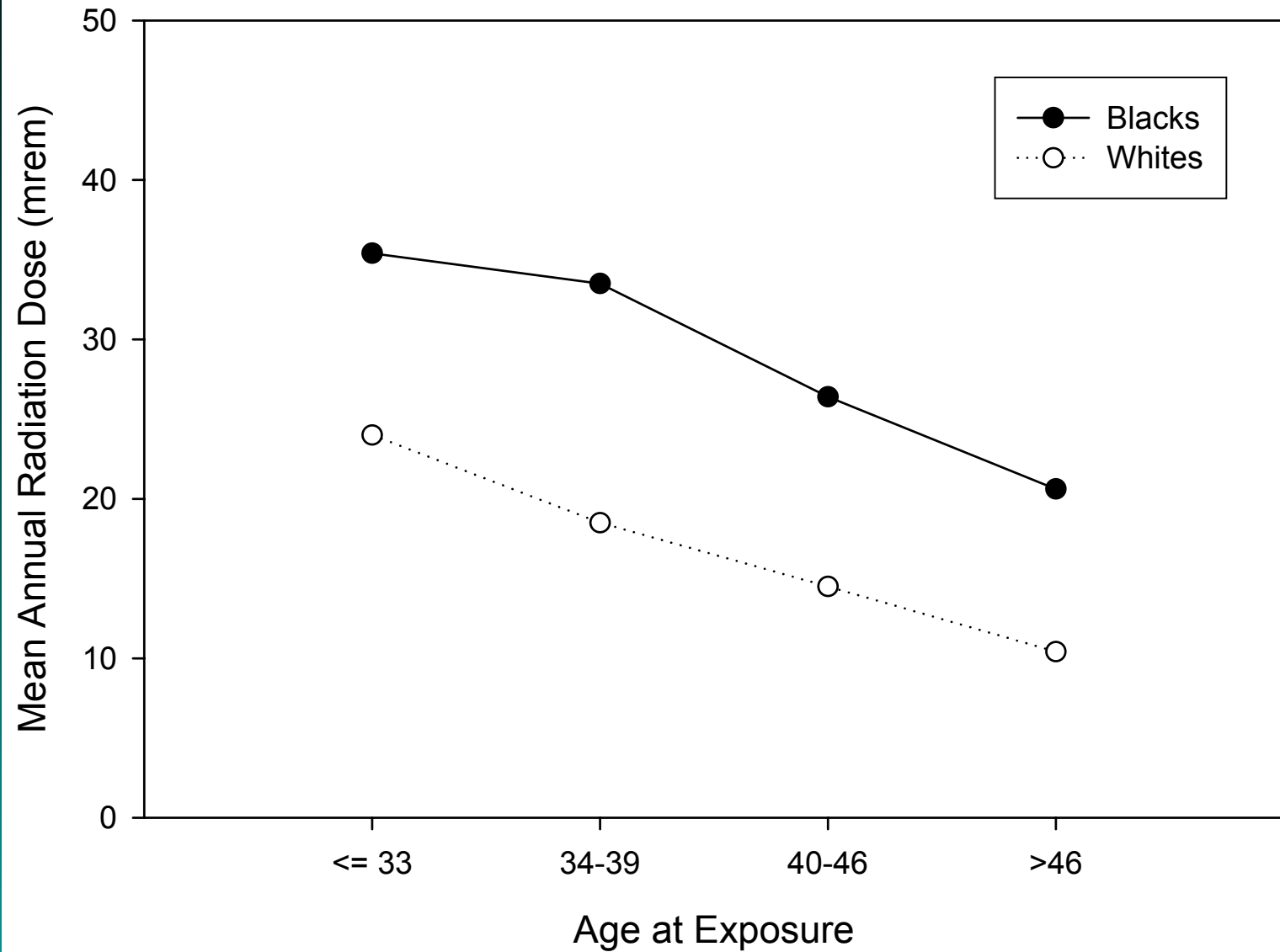
Distribution of Black Workers by Monthly Pay Category and Average Building Dose, Savannah River Site, 1991-1998



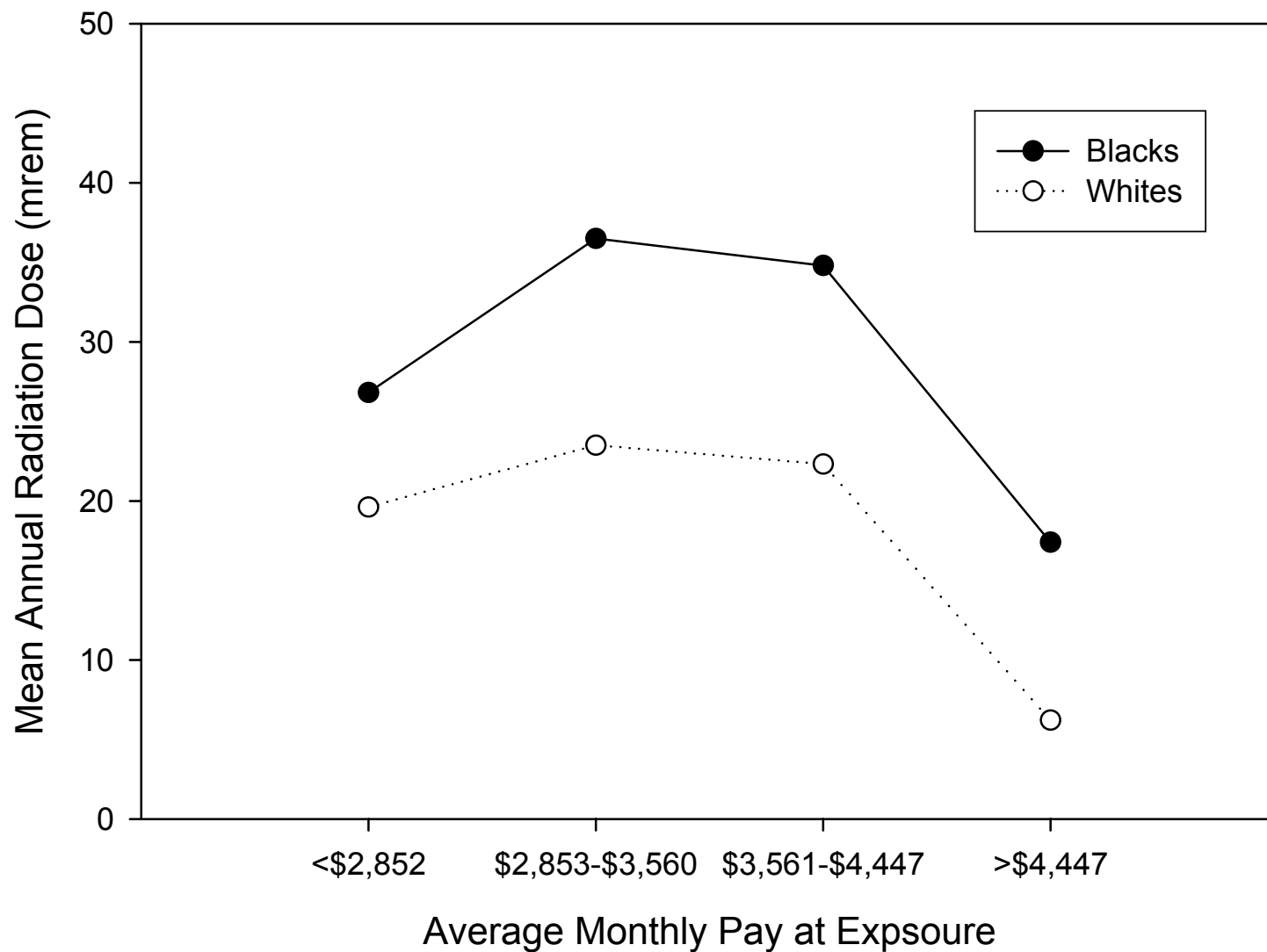
Distribution of Black Workers by Job Category and
Average Building Dose,
Savannah River Site, 1991-1998



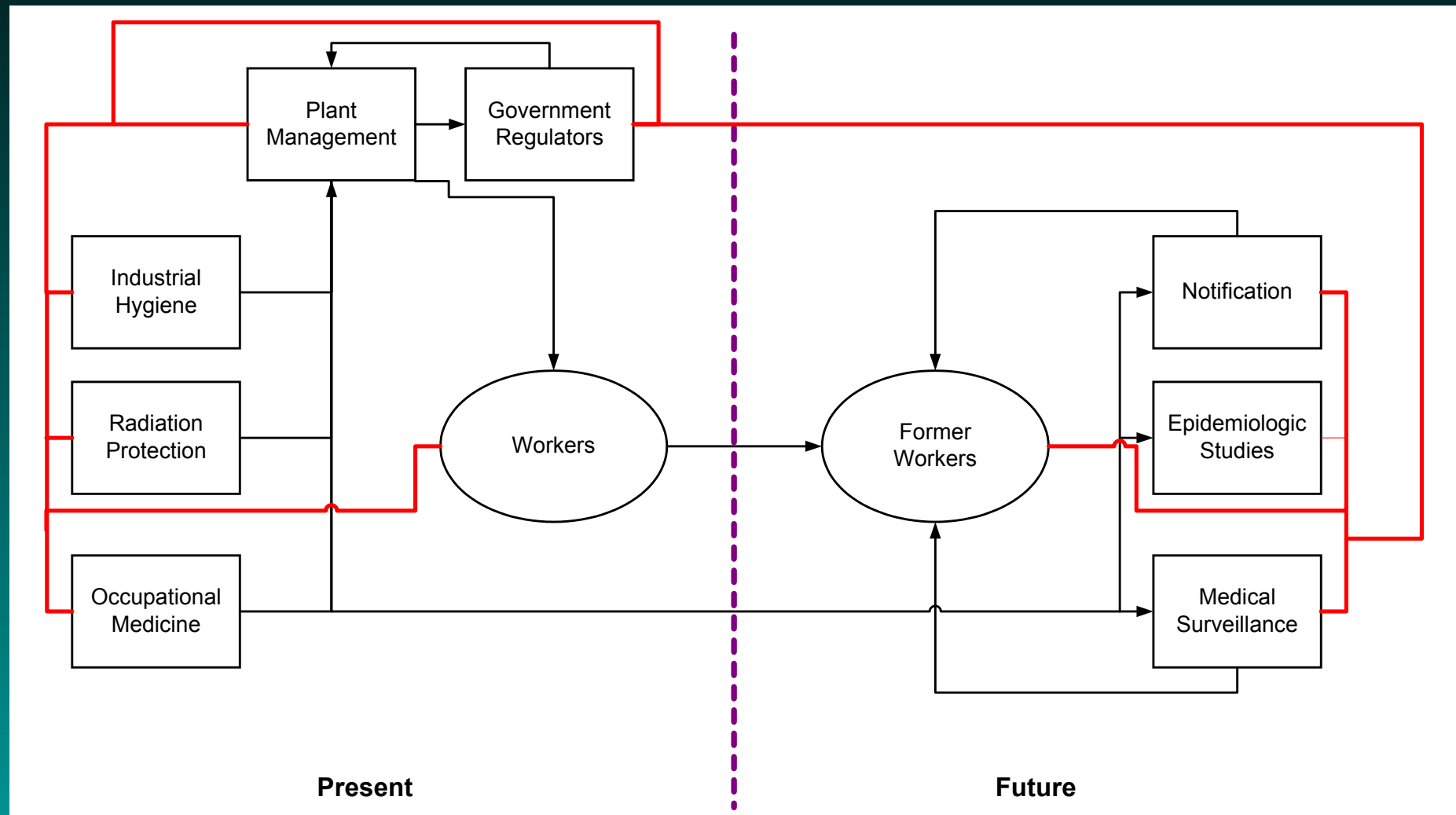
Mean Annual External Radiation Dose by Age Exposed Savannah River Site, 1991-1998



Mean Annual External Radiation Dose by Average Monthly Pay at Exposure Savannah River Site, 1991-1998



Workplace with Exposure Surveillance and Epidemiology



Solutions

- Must have buy-in from management
- Need governmental support
- Surveillance as a “standard practice” for IHs and HPs
- Epidemiologic perspective needs to be integrated into workplace
- Surveillance must be demonstrated to be cost-effective
- Surveillance data systems extend beyond workplace
- Need advocates for surveillance data systems and tool boxes for implementation
- Incentives for academic–industry partnerships